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RESEARCH

FATIGUE ALARMS IN INTENSIVE CARE: DESCRIBING THE PHENOMENON THROUGH INTEGRATIVE LITERATURE REVIEW*

FADIGA DE ALARMES EM TERAPIA INTENSIVA: DESCREVENDO O FENÔMENO ATRAVÉS DA REVISÃO INTEGRATIVA DA LITERATURA

FATIGA DE ALARMAS EN CUIDADOS INTENSIVOS: DESCRIBIR EL FENÓMENO MEDIANTE LA REVISIÓN INTEGRADORA DE LA LITERATURA

Adriana Carla Bridi[1], Roberto Carlos Lyra da Silva[2], Jorge Leandro do S. Monteiro[3]

ABSTRACT

Objective: To analyze scientific publications about alarm monitoring and alarm fatigue phenomenon in intensive care. **Methods**: Integrative review of literature held in databases Lilacs, PubMed and SciELO. **Results**: After analyzing the productions elucidate the concepts and definitions of the phenomenon, predisposing factors and strategies to minimize them, the relationship with patient safety, achieving time frame 1993 to June 2010. Fatigue alarm occurs when a large number of alarms covers those clinically significant, enabling relevant alarms are disabled, silenced or ignored by staff. The excessive number of alarms makes indifferent staff, reducing your alertness, leading to distrust of the sense of urgency of alarms, resulting in lack of response to alarms relevant. **Conclusion**: The technological apparatus requires attention of professionals to ensure patient safety serious. **Descriptors**: Intensive Care Monitoring, Clinical Alarms, Iatrogeny, Patient Safety.

RESUMO

Objetivo: Analisar as publicações científicas acerca de alarmes de monitorização e do fenômeno Fadiga de alarmes em terapia intensiva. **Métodos**: Revisão integrativa de literatura realizada nas bases de dados Lilacs, PubMed e SciELO. **Resultados**: Após análise das produções elucidaram-se os conceitos e definições do fenômeno; fatores de predisposição e estratégias para sua minimização; a relação com a segurança do paciente, alcançando recorte temporal de 1993 a junho 2010. A fadiga de alarmes ocorre quando um grande número de alarmes encobre aqueles clinicamente significativos, possibilitando que alarmes relevantes sejam desabilitados, silenciados ou ignorados pela equipe. O número excessivo de alarmes torna a equipe indiferente, reduzindo seu estado de alerta, levando à desconfiança do sentido de urgência dos alarmes, resultando em falta de resposta a alarmes relevantes. **Conclusão**: O aparato tecnológico exige atenção dos profissionais para garantir a segurança do doente grave. **Descritores**: Terapia Intensiva, Monitorização, Alarmes Clínicos, Iatrogenia, Segurança do Paciente.

RESUMEN

Objetivo: Analizar las publicaciones científicas sobre monitoreo de alarmas y el fenómeno de la fatiga alarma en cuidados intensivos. **Métodos**: revisión integradora de la literatura realizada en las bases de datos Lilacs, PubMed y SciELO. **Resultados**: Tras el análisis de las producciones dilucidar los conceptos y definiciones del fenómeno, los factores predisponentes y estrategias para minimizarlos, la relación con la seguridad del paciente, logrando marco de tiempo de 1993 a junio de 2010. Fatiga alarma se produce cuando un gran número de alarmas abarca aquellos clínicamente significativa, permitiendo alarmas pertinentes están desactivados, silenciadas o ignoradas por el personal. El excesivo número de alarmas que hace el personal indiferente, lo que reduce su estado de alerta, lo que lleva a la desconfianza en el sentido de la urgencia de las alarmas, lo que resulta en una falta de respuesta a las alarmas correspondientes. **Conclusión**: El aparato tecnológico requiere atención de los profesionales para garantizar la seguridad del paciente grave. **Descriptores**: Monitoreo de Cuidados Intensivos, Alarmas clínicas, Iatrogenia, la Seguridad del Paciente.

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INTRODUCTION

Monitoring systems used in intensive care units (ICU) allow continuous monitoring of seriously ill patients and early identification of physiological changes, enabling decision making for implementing therapeutic in a short time. However, this time depends on a rapid and effective response team to alarms of these systems.[1]

The progress of intensive care has been accompanied by the development of technologies for monitoring invasive and noninvasive bedside. The monitors have alarms for a variety of physiological variables, with the purpose of providing security to seriously ill patients, who benefit the team be alerted to changes in vital parameters. As the number of variables to be monitored has increased because of the increasing incorporation of technology in the ICU, so the number of alarms in these units and this fact may become a problem, so the issue of alarms should be a concern among professionals intensive care.

Thus, the technological apparatus and its alarms, has demanded increasingly the attention of professionals to ensure patient safety that benefits him. Although alarms have as its purpose to strengthen patient safety, its improper use can compromise it, conveying a false sense of security.

The ECRI Institute, a nonprofit independent American nonprofit based in Pennsylvania / USA, means that research can improve the safety, quality and cost-effectiveness of care in hospitals. With extensive experience in the analysis of hazards related to medical devices and patient safety, the organization elected alarms multiparameter monitors as number ONE on your list of top 10 health technology hazards for 2012.[2]

Besides the ECRI Institute research and discuss the issue of alarm, the international scientific literature has been publishing articles related to problems with alarms for over 10 years. In Brazil publications with it are insufficient.

Article published in January 2010 describes a problem of intensive care, the phenomenon of fatigue alarm. The monitors are used to monitor patients and alert staff to deviations from a predetermined status. However, fatigue alarm occurs when a large number of alarms cover those clinically significant, enabling relevant alarms are disabled, silenced or ignored by staff. The excessive number of alarms makes indifferent staff, reducing your alertness, leading to distrust of the sense of urgency of alarms, resulting in lack of response to alarms relevant. Although alarms are important, preserving lives, they can compromise the safety of patients if they are not valued by the team.[3]

Given the relevance of the topic, the objective of this study was to search and analyze, through integrative review of literature, the knowledge produced relates to problems with clinical monitoring alarms and alarm fatigue phenomenon, highlighting its concepts and definitions, predisposing factors, strategies to minimize and their interfaces with patient safety in intensive care.

To guide this study was formulated the following question: What are fatigue alarms and how do they relate to patient safety in intensive care?

METHODOLOGY

It is an integrative review of literature which includes analysis of relevant research that support for decision making and improving clinical practice, enabling the synthesis of the state of knowledge of a particular subject, while identifying knowledge gaps that need to be filled with new studies. [4]

We conducted an integrative review of the literature by searching the databases Lilacs, PubMed and SciELO, accessed by the Virtual Health Library (VHL) and CAPES Journals Portal using the keywords / MeSH and their combinations in Portuguese and English: intensive care monitoring, alarms clinical, technology, latrogenesis, patient safety. The research took place in the first half of 2010.

Inclusion criteria in the selection of studies were abstracts or full articles available in databases, published in English or Portuguese, with themes related to clinical alarms, alarm fatigue and patient safety. We have reached a time frame of 1993 to June 2010, of the 90 studies were selected because their influence on current jobs. Studies included in the review: observational, descriptive surveys, intervention, exploratory, prospective and retrospective. Selected review articles and editorial by the value of the information contained therein.

RESULTS AND DISCUSSION

The studies are presented highlighting the concepts and definitions of fatigue alarm, its predisposing factors and current strategies to minimize them, in addition to problems related to equipment alarms and patient safety.

Table 1 presents the selected publications with title, authors, methods, study site, year and journal of publication.

Title	Authors	Methods	Country / State	Journal and Year
Intensive Care Unit Alarms - How Many Do We Need?[5]	Siebig S, Kuhls S, Imhoff M, Gather U, Schölmerich J, Wrede CE	Clinical Study observational prospective	Germany	2010 Crit Care Med
Annotated Collection of Critical Data In Validation Study for Alarm Algorithms In Intensive Care - The methodologic Framework[6]	Siebig S, Kuhls S Imhoff M, Langgartner J, Reng M, Scholmerich J, Gather U, Wrede CE	Study prospective observational	Germany	2010 J Crit Care
Alarms Monitor Alarm Fatigue: Standardizing Use of Physiological Monitors and Decreasing Nuisance Alarms[3]	Graham KC, Cvach M	Intervention Study	USA	2010 Am J Crit Care
Adverse Events in Nursing Care in an Intensive Care Unit (ICU)[7]	Beccaria LM Pereira RAM, Contrin LM, Lobo SMA, Trajano DHL	A descriptive study	Brazil / Sao Paulo	2009 Rev Bras Ter Intensiva
National Online Survey on the Effectiveness of Clinical Alarms[8]	Korniewicz DM, Clark T, David Y	A descriptive study	EUA	2008 Am J Crit Care
Identifying Risks Hospitalized Patient[9]	Lima LF, Leventhal LC, Fernandes MPP	A descriptive study	Brazil / Sao Paulo	2008 Einstein
Alarm Algorithms in Critical Care Monitoring[10]	Imhoff M, Kuhls S	Article review	Germany	2006 Anesth Analg

Title	Authors	Methods	Country / State	Journal and Year
Latrogenic events in the Intensive Care Unit: Analysis of Factors Related [11]	Padilha, KG	Prospective descriptive study	Brazil / Sao Paulo	2006 Rev Paul Enferm
Current Equipment Alarm Sounds: Friend or Foe?[12]	Steven Dain	Editorial	Canada	2003 Can J Anesth
Alarms in the Intensive Care Unit: How Can the Number of False Alarms Be Reduced?[13]	Chambrin MC	Article review	France	2001 Crit Care Med
Are Auditory Warnings In the Intensive Care Unit Properly Adjusted?[14]	Solsona JF, Altaba C Maúll E, Rodriíguez L, Bosqué C, Mulero A	Study of intervention	Spain	2001 J Adv Nurs
Management of Technology in Intensive Care[15]	Madureira CR, Veiga K, Santana AFM	A descriptive study	Brazil / Bahia	2000 Rev Lat Am Enfermagem
Multicentric Study of Monitoring Alarms in the Adult Intensive Care Unit (ICU): A Descriptive Analysis[16]	Chambrin MC, Ravaux P, Aros Calvelo D, Jaborska A Chopin C, Boniface B	A prospective observational	France	1999 Intensive Care Med
Poor Prognosis for Existing Monitors in the Intensive Care Unit[17]	Tsien CL, Fackler JC	A prospective observational	USA	1997 Crit Care Med
Are There Too Many Alarms In the Intensive Care Unit? An Overview of the Problems[18]	Meredith C, Edworthy J	A descriptive study	England	1994 J Adv Nurs
Audibility and Identification of Auditory Alarms in the Operation Room and Intensive Care Unit[19]	Momtaham K, Hetu R Tansley B	Observational study	Canada	1993 Ergonomics

Table 1: Publications included in the review: title, authors, methods, study place, year and journal of publication, 2012

In Table 2 we present selected publications, title, objectives, methods and its results.

Title	Objectives	Methods	Results
Intensive Care Unit Alarms – How Many Do We Need?[5]	To provide a database of reference for application of alarm algorithm research and implementation of smart alarm monitoring systems.	Prospective observational clinical study	During 982 hours of observation, were recorded alarm 5934, 40% of all alarms is not described properly and the patient's condition was classified as false technically, 885 (15%) of total alarms are relevant.

Title	Objectives	Methods	Results
Collection of Annotated Data In a Critical Validation Study for Alarm Algorithms In Intensive Care A Methodologic Framework[6]	To create a database with physiological measures of clinical alarms.	Prospective observational clinical study	A total of 3682 alarms were recorded. The results showed that 16.6% of all alarms were relevant and 43.6% of the total were false. The video-assisted system for collecting real-time data monitoring enabled annotations clinically relevant events in periods of 24 hours continuously reducing bias.
Monitor Alarm Fatigue: Standardizing Use of Physiological Monitors and Decreasing Nuisance Alarms[3]	Seeking solutions for alarm fatigue, reduce false alarms positive	Intervention Study	Through changes in alarm systems with the participation of personnel of the unit, there was a 43% reduction of physiological alarms when compared with the database collected prior to the beginning of the changes.
Adverse Events in Nursing Care in an Intensive Care Unit (ICU)[7]	Identify adverse events in nursing care in an ICU.	A descriptive study	550 adverse events were reported with 37 alarms related to equipment used incorrectly, they were dead, with incorrect parameters and low volume
National Online Survey on the Effectiveness of Clinical Alarms[8]	Determine the problems associated with alarms in hospitals and evaluate the reasons of health professionals do not respond to alarms clinicians.	A descriptive study	A total of 1,327 people responded to the survey, where (51%) were nurses and one third (31%) worked in ICU. Most respondents considered as a nuisance alarms that interrupt the care and agreed that false alarms can reduce the confidence of the team leading the team to disable them.
Identifying Risks Hospitalized Patient[9]	Identify the risks reported in a public institution and about the main risks of the patients in the opinion of nurses.	Retrospective descriptive study	440 sentinel events were reported. The main risks are: falling patient, medication errors and pressure ulcers. We interviewed 65 nurses, which also reported patient falls, medication errors and pressure ulcer care as key risks. As for events with alarms and equipment, there were 45 (10.2%) notifications of failures alarms.

Title	Objectives	Methods	Results
Alarm Algorithms in Critical Care Monitoring[10]	Discuss the algorithms alarm monitoring in intensive care	Review article	There have been major technological advances of medical devices and equipment, alarm systems but these advances have not kept pace. In practice the alarm systems have high sensitivity and low specificity, false positivity with the parameters
Latrogenic occurrences in ICU: analysis of factors related[11]	Identify the structural factors of intensive therapies and patients' conditions related to iatrogenic occurrences and severity of these occurrences.	Prospective descriptive study	The study identified the factors structural of the units and the conditions of patients Related to occurrences iatrogenic and its severity. Of the 113 iatrogenic occurrences, 18.6% were related to equipments. In 26.5% there was threat moderate and severe to life. The occurrences iatrogenic Related to human resources were 89.4%.
Current Equipment Alarm Sounds: Friend or Foe?[12]	Discuss issues related to medical equipment alarms	Editorial	The author draws attention to the problems of alarm systems related to sound, visual signals and settings, suggesting improvements by manufacturers related to auditory signals, visual and configuration
Alarms in the Intensive Care Unit: How Can the Number of False Alarms Be Reduced?[13]	Raise issues with alarms and monitoring goals, discussing the issue of the many alarms in existing monitoring systems	Article review	Approaches to improve the situation for the author are: organizational and behavioral one hand and by another technique. Organizational refers to the correct use of monitoring units and technical solutions should from the manufacturers in improving technology
Are Auditory Warnings In the Intensive Care Unit Properly Adjusted?[14]	Determine whether auditory alarms / audible in an ICU were adjusted accordingly	Intervention Study	Authors evaluated whether the alarms in the ICU were adjusted according to the patient's clinical condition and showed that the fit was not right. It was adopted as routine by the team setting alarms individualized for each patient. The routine was effective for the improvement of the alarms in the unit.

Title	Objectives	Methods	Results
Management of Technology in Intensive Care[15]	Check knowledge of the healthcare team in relation to the handling of equipment and its technical and operational specifications	A descriptive study	The equipment was considered by professionals as a tool in the care process, but there was a lack of health staff in relation to the handling of equipment and its technical and operational specifications.
Multicentric Study of Monitoring Alarms in the Adult Intensive Care Unit (ICU): A Descriptive Analysis[16]	Assess the relevance of monitoring alarms	A prospective observational	Confirmed the low specificity, but the high sensitivity of these systems generate a large number of false positive alarms.
Poor Prognosis for Existing Monitors in the Intensive Care Unit[17]	To evaluate the false positive alarms and their causes frequent	A prospective observational	From a total of 2942 alarms in 298 hours of observation, 86% were false positives, clinically irrelevant 6% and 8% of clinically relevant alarms. Alarms which resulted in interventions in patients received percentage of 18%. Pulse oximeter alarms caused more false positives for problems in connections or bad contact.
Are There Too Many Alarms In the Intensive Care Unit? An Overview of the Problems[18]	Discuss the relationship worrying health team with monitoring alarms in the ICU and the existence of many alarms in ICU	A descriptive study	The existence of many alarms in ICU leads the team did not meet the health alarms. There is no standard among manufacturers of audio equipment alarm sounds, the same physiological parameter has different sounds alarms on monitors of different manufacturers and alarm systems do not have a mapping of emergencies, there is no relationship between the alarm and the medical emergency.
Audibility and Identification of Auditory Alarms in the Operation Room and Intensive Care Unit[19]	To investigate the audibility and identification of 23 alarms and 26 impaired ICU audible alarms in the operating room of a hospital	Observational study	Demonstrated the poor design of auditory warning signs and the need for standardization of medical equipment alarms, faults seen in the auditory perception of staff towards them.

Table 2: Selected publications, title, objectives, methods and its results, 2012

A study conducted in a university hospital, a 12-bed ICU, showed a high rate of false alarms of current surveillance systems cardiovascular function in these systems possess high sensitivity and low specificity. [5]

5934 alarms were recorded during 982 hours of observation, corresponding to 6 per hour. About 40% of all alarms are not described properly and the patient's condition was classified as technically false. Only 885 (15%) of all alarms were considered clinically relevant. This study provided the basis of clinical data with physiological data, to the development and implementation of algorithms to modify or replace limit alarms and improve its specificity, the "smart alarms". Constant noises adversely affect the working conditions of staff and cause stress in ICU patients. Moreover, the high number of clinically irrelevant alarms leads to reduced alertness team, which may result in lack of response to alarms relevant, not offering security accompanying a patient. [5]

Another study proved again the high sensitivity and low specificity of alarms. Data collection was performed on a 12-bed ICU of a university hospital where patients with heart rate monitoring, invasive blood pressure and oxygen saturation were included in the study. Numerical data, physiologic monitor alarms and threshold alarms were extracted to a surveillance network through recordings performed at the bedside with a video camera. Data were evaluated by an experienced physician and alarms were categorized according to their technical validity and clinical relevance.[6]

A total of 3682 alarms were recorded, corresponding to 68.2% 2512 were alarm limit, 535 (14.5%) alarms hazardous, 535 well (14.5%) technical alarms and 100 (2.7%) of arrhythmia alarms . Of the total 54.5% of alarms were judged technically true and false technically 43.6%, 1.9% could not be judged. [6]

Of vital parameters, what else was sparked alarm systolic blood pressure (invasive) with 45.4%, followed by 29.5% of the alarms oxygen saturation. A high percentage of 44.2% was caused by handling of the team. Only 16.6% of all alarms have been classified as relevant clinical situations, versus 46.5% non-relevant. When many alarms are generated, since the high sensitivity of their systems, there is a depreciation of its clinical value and reducing the degree of attention from the staff about them. The study was a database to develop and evaluate algorithms for intelligent alarms that can help reduce the number of false alarms in intensive care, favoring patient safety. [6]

Work developed at first in a semi-intensive unit with 15 beds met clinical engineers, nurses, doctors and managers. Concern for patient safety and spurred the study team made changes in alarm systems with the participation of personnel of the unit, to face the "alarm fatigue". The authors emphasize that alarms alert staff intend to deviations from normal or acceptable predetermined status, however, occurs when the fatigue of the team silences alarms, disable or ignore these alarms, making it insensitive to them and compromising patient safety. Nurses Unit considered a nuisance alarms and said that serving them would interrupt patient care. The high number of false-positive alarms sound conditions the professional no longer consider them as indicators of a potential emergency situation, but only as "noise", the authors point. Some measures have been adopted in the unit. Types (parameters) and frequency (levels and tones) alarms were adapted to the need of unity and criticality of patients. Nurses have been trained to distinguish and set limits and alarm levels of the parameters according to the clinical condition of the patient. The software monitors was modified to promote better audibility of the alarm tones. As a result there was a 43% reduction of physiological alarms when compared with the base

data collected prior to the onset of changes. This reduction of alarms can be attributed to careful delineation individualized levels and limits of the parameters of alarms per patient adherence and implementation of policy and interdisciplinary monitoring, necessary measures, according to the authors, to minimize fatigue alarm.[3]

Study identified the occurrence of adverse events in ICU with 20 beds in a general hospital in Sao Paulo / Brazil, for ten months. We recorded 550 adverse events, 37 related to alarms from equipment used incorrectly, they were dead, with incorrect parameters and volume low, demonstrating the fragility of monitoring and consequences for patient safety. [7]

A multidisciplinary study was conducted to determine from hospitals and health care problems associated with alarms. The survey of the effectiveness of clinical alarms was done online by a research team composed of 16 members and represented by clinical engineers, nurses and clinical technologists, from August 2005 to January 2006, with the objective to analyze the reasons why health professionals did not respond to clinic alarms.[8]

From a total of 1,327 respondents, 51% were nurses and 31% worked in ICU, 90% of respondents agreed with the statement that the study is necessary to prioritize and categorize alarms in intensive care so that staff can easily distinguish them visually and hearing. A percentage of 81% of respondents identified as false alarms problem, besides generating discomfort and frustration on the team, 77% of respondents said that the noise of the alarm interrupts patient care and 78% of the alarms that the frequency decreases confidence in urgency of these alarms, leading the team to turn them off. [8]

Complexity of alarm systems and configuration parameters, inadequate visual and sound, central alarm management, information integration and deficit personnel to respond to alarms were other issues raised. [8]

Administrative and educational measures are necessary for effectiveness and patient safety alarms in the units, and measures from the manufacturers of the equipment on improving alarm systems. For the authors, the complexity of the equipment requires training for their correct and proper time for setup and configuration. The physical plant of the units must facilitate visualization of alarms and audibility. Despite the abundance of devices in alarm equipment, alarm-related adverse events still occur frequently. The study concludes that for managing clinical alarms become effective are needed: equipment design with appropriate use of the multidisciplinary team, staff willing to learn to use the equipment safely and hospitals that recognize the complexity of managing clinical alarms and provide resources necessary to develop effective schemes to manage this.[8]

Authors raised the risks reported by the health team to Risk Management in a hospital-large school of São Paulo / Brazil, from July 2006 to July 2007. There were records of 440 sentinel events reported. The main risks notified: Fall of patient, medication errors and pressure ulcers. We interviewed 65 nurses, which also list these risks as frequent assistance. As for adverse events related alarms were recorded 45 reports of failures of equipment alarms, corresponding to 10.2% of total notifications.[9]

Review article discussed the algorithms alarm monitoring in the ICU. Frequent false alarms are not just a nuisance for patients and staff, also compromise patient safety and efficiency of care. To the authors were no major technological advances of medical devices and equipment; however the alarm systems have lagged those advances. In practice the alarm systems have high sensitivity and low specificity, false positivity with the multiparameter monitor. As advances in

solution algorithms alarms are needed, with computational and statistical methods applied in the clinic. [10]

Study produced in seven ICUs of São Paulo / Brazil for 30 days identified the factors and structural characteristics of the patients' conditions relating to the occurrence and severity of iatrogenic occurrences. Of the 113 incidents identified, 18.6% were related to equipment. 26.5% were moderate or severe threat to life. Events related to human resources were 89.4%. The conclusion points to the need for investment in education team, the structural conditions and material resources in these units for prevention of iatrogenic occurrences and the importance of further studies on the topic. [11]

In an editorial for the Canadian Journal of Anesthesia, the author discusses some points regarding medical equipment alarms. The author puts the sound of alarms is not appropriate because not convey the sense of urgency in accordance with the patient's situation, are difficult to identify, frighten patients and staff. The operation mode of the volume of these alarms cause problems. He also states that the visual alarm signals do not transmit a sense of urgency. Finally, he points out that the setting, the control system alarms, the operating mode and limit the parameters are difficult to handle. All these problems related to alarms monitoring impact on quality of care and patient safety serious.[12]

The author also points out that the alarm system ideal could not scare or bother visually or aurally, should be high enough to be noticed in any area and not be masked by other noise, but also not harm the communication between people and patients. The audio signal should prioritize and communicate risk and sense of urgency for the team. He emphasized that the controls, subtitles, language and configuration should be easy to understand and access, suggested that the sounds of the alarms were standardized to the level of criticality necessary in all types of equipment. [12]

Review article raised some issues with alarms and monitoring goals, discussing the issue of the many existing alarms and monitoring systems that are not normally seen as useful for the team, because of the high incidence of false alarms or no clinical significance. [13]

The approaches to improve the situation are presented by the author in two main aspects: organizational and behavioral one hand and by another technique. Organization refers to the correct use of the monitoring units, according to scientific recommendations, which could reduce false alarms. Technical solutions should leave the manufacturers to improve the technology of some sensors (sensors oximeter, for example) to reduce artifacts and analysis systems for better event detection and reduce the number of false alarms, audible alarms are generated by a threshold value and so this is a source of false alarms.

The low specificity of alarms leads to negative consequences in care in ICUs. Alarms can cause sleep deprivation and stress on patients and staff. The constant demand can result in delays in intervention because the team has to recognize the origin of alarms from various sources in the units (monitors, mechanical ventilation, infusion pumps, dialysis systems, among others), assign a meaning to this alarm, and then intervene if necessary after evaluation. An alarm event on a monitor may be a technical defect, such as a misplaced electrode, interference or severe arrhythmia. Off redundant alarms is often the solution found by the team, but patient safety is not assured, concludes the author.[13]

Authors evaluated whether the alarms in a medical-surgical ICU of 12 beds in an educational institution were properly adjusted according to the actual need of the patient and the study showed that the adjusted values were not adequate. From the result was adopted as a

daily routine for the unit team setting alarms according to the condition of the patient, which were recorded in the medical records. The routine was effective for the improvement of working conditions of staff in the unit and consequently on patient safety. [14]

In a descriptive study ICU of a large general hospital, equipment were considered by professionals as essential tools in the care process, however there was a lack of health staff in relation to the handling of equipment and its technical and operational specifications. The authors pose the question as worrying demonstrate that when the team uses the equipment without knowing them, indicating a lack of training in practice. [15]

Multicenter, prospective observational developed in ICUs of two university hospitals and three general hospitals, with the aim of evaluating the relevance of monitoring alarms, confirmed the low specificity but high sensitivity of these systems that generate large numbers of false positive alarms. There were records of 3,188 alarms in 131 critically ill patients included in the study, an average of an alarm every 37 minutes, 23.7% were in the team for handling patient, 17.5% due to technical problems and 58.8% by changes in patients. Fans originated 37.8% of the alarms, 32.7% cardiovascular monitors, pulse oximeters capnographs 14.9% and 13.5%. 25.85% of these alarms led to reposition the sensor or electrode modification and therapy (drug or ventilation). Only 5.9% of the alarms generated medical evaluation. The sensitivity of the alarms was 97% and specificity of 58%. The positive predictive value of an alarm was 27% and its negative predictive value was 99%, demonstrated this multicenter study confirms that the large number of false positive alarms in ICU. [16]

This prospective observational study conducted in the ICU of a university hospital child evaluated false positive alarms and their causes frequent. From a total of 2,942 alarms in 298 hours of observation, 86% were identified as false positives, 6% and 8% clinically irrelevant alarms with clinical relevance. The study ranked the alarms that were associated with interventions for patients and the percentage was 18%. The pulse oximeter alarms caused more false positives for problems in connections or bad contact, which requires improvements in its systems for its low reliability, the study suggests.[17]

Study performed by the department of occupational health and psychology at a university in England highlighted the existence of many alarms in the ICU, some high and continuous, which can irritate the healthcare team. The lack of standard among manufacturers of audio equipment sounds alarm worsens the problem, the same physiological parameter has different sounds alarms on monitors from different manufacturers. Another problem would be the lack of alarm systems in mapping emergency because there is no relationship between the alarm and the medical emergency. To the authors these problems lead the team to disregard alarms flags emergency clinic and not serve them. The study of the 90 discussed the concern regarding the health care team with the alarm monitoring in the ICU. [18]

The Audibility and identification of auditory alarms in the ICU 23, and 26 auditory alarms in the operating room of a Canadian teaching hospital, were investigated. Digital recordings of the alarms were made and presented to staff their units in order to determine how many alarms would be identified by them. In the recordings, multiple alarms masked other alarms in the same area and in many operating rooms were muffled by the sound of a saw or drill surgery. The surgical center staff (anesthetists, anesthesia residents and technologists) was able to identify an average of 10 and 15 of the 26 alarms found in the unit. The ICU nurses identified an average of 9 and 14 of the 23 alarms found in

the unit. This study demonstrated the poor design of auditory warning signs and the need for standardization of medical equipment alarms, faults seen in the auditory perception of the team in relation to alarms.[19]

In 2011, the Association for the Advancement of Medical Instrumentation (AAMI) puts that fatigue alarm occurs when: the team is overloaded with conditions of 350 alarms per patient per day, a life-threatening event is truly lost in a cacophony of noise because of the multitude of devices with alarm signals competitors, all trying to get the attention of someone without proper clarity and because it is supposed to do, not inconsistent alarms warn or provide reliable information suggesting and guiding actions to be taken by the team, the team of health becomes insensitive to alarms, resulting in lack of response or time extension of stimulus-response. [20]

Studies show high false alarm rate of current monitoring systems in terms of these systems possess high sensitivity and low specificity, predisposing to fatigue phenomenon alarms.

Constant noises adversely affect the working conditions of staff and cause stress in hospitalized patients, and sleep deprivation. Alarms irrelevant lead to reduced alertness team and distrust in its sense of urgency, resulting in lack of response to relevant. When disable, mute, skip or delay the response time to alarms, health professionals also retard the timing for the implementation of therapeutic or significant changes in patients cannot be perceived, not providing security monitoring. Incorrect use of equipment, alarms dead, with low volume and inadequate parameters are related to adverse events with medical electrical equipment.

Difficulties in the configuration, control system, operation of equipment, alarms and parameters limit visual and auditory signals without standardization, lack of health staff in relation to the handling of equipment and its technical and operational specifications, as well as personal deficit units to respond to alarms are raised and issues discussed in the studies.

The parameters adjusted daily alarms based on each patient's clinical team and her participation in this process and in training, greater involvement with the clinical engineering units. Investing in the education of staff, structural conditions and material resources in the ICU. Improved technology by manufacturers in the systems analysis and alarms, seeking to reduce the number of false alarms, and equipment with easy handling for the team. All these proposals are solutions designed to minimize fatigue and alarms become necessary for the safety of critically ill patients in intensive care that depends on the technological apparatus for life support.[6]

CONCLUSION

This review aimed to elucidate fundamental aspects related to fatigue and raise the alarm problems related to alarms and monitoring patient safety.

Patient safety should be considered in the acquisition and incorporation of technology in the ICU, for such the qualification and training of health professionals becomes indispensable. Adverse events related to mishandling and misuse of equipment in these units are described. Deficiencies in planning, organization and personnel dimension may contribute to the occurrence of these events.

Although alarms with low clinical relevance may be more common than those of high clinical relevance, all alarms need to be valued by health professionals, for discernment and evaluation of the patient by the practitioner are essential in detecting changes or solve problems related monitoring.

New technologies are emerging continuously, but we observed that the low specificity of alarms seems to linger. The equipment manufacturers offer systems with the possibility of monitoring multiple physiological parameters and different schedules, however promising it would be an investigation of the impact of incorporating these technologies in daily units.

We understand that the review was of paramount importance for the construction of state of the art alarm fatigue construct and understanding of the phenomenon, hopefully lead the healthcare professionals and manufacturers of electrical equipment for a critical reflection on the technological evolution that accompanies us on intensive care units in the context of patient safety.

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